



New record of *Serpocaulon triseriale* (Sw.) A.R. Sm. (Polypodiaceae) in Argentina, with morphological comparison of relatives

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Abstract

Serpocaulon triseriale (Sw.) A.R. Sm. is considered the most widespread species in the genus. It has been recorded from south of Mexico to Bolivia, Paraguay and Brazil. Here, we expand its distribution by reporting a new record from Salta province, Argentina, based on material that was previously misidentified as *S. polystichum* (Link) A.R. Sm. We compare the *S. triseriale* and *S. polystichum* with their relatives (*S. attenuatum* (Humb. & Bonpl. ex Willd.) A.R. Sm., and *S. rex* Schwartsb. & A.R. Sm.), providing photographs of the plants in the field, SEM images of the spores and light photos of the rhizome scales to discriminate *S. rex* from *S. triseriale*. In addition, distributional records are included.

Key words

Argentine flora, distribution range, ferns, *Serpocaulon polystichum*, *Serpocaulon rex*.

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Introduction

Serpocaulon A.R. Sm. (Polypodiaceae) is a tropical American fern genus (Smith et al. 2006), which presents its highest diversity in the Andes of Colombia (Sanín 2018), Bolivia (Smith et al. 2018), and in the Atlantic Rain Forest of Brazil (Labiak and Prado 2008).

Several new taxa of *Serpocaulon* have been described or recognized recently (Labiak and Prado 2008, Rojas and Chaves-Fallas 2013, Schwartsburd and Smith 2013, Sanín 2014, 2015, 2018, Sanín and Torrez 2014, Chaves-Fallas et al. 2015). However, data on the distribution, ecology and conservation of this genus is mostly incomplete (Sanín 2018). The lack of knowledge on this genus is promoted by several factors, such as high levels of morphological and molecular homoplasies (Hensen

1990, Kreier et al. 2008), frequent hybridization (Sanín and Torrez 2014, Sanín 2018), and unclear nomenclature (Sanín and Salino 2018), supporting the need of a modern monograph (Smith et al. 2006, Sanín 2018).

There are several recent publications that try to remediate the incomplete and inaccurate knowledge on the distribution of *Serpocaulon* species. Batke and Hill (2013) expanded the distribution of *S. lasiopus* (Klotzsch) A.R. Sm., which was previously known from Venezuela to Brazil (Smith et al. 2006), to include Nicaragua to Argentina. More recently, *S. latissimum* (R.C. Moran & Øllg.) A.R. Sm., which was originally thought by Moran and Øllgaard (1995) to be an Ecuadorian endemic, had its range extended to include Bolivia and Brazil (Sanín 2018, Smith et al. 2018).

An interesting case is *Serpocaulon triseriale* (Sw.) A.R. Sm. (Fig. 1), the most widely distributed species in the genus (Smith et al. 2006, 2018, Sanín 2018), which is known from southern Mexico to Bolivia, Paraguay, and Brazil (Smith et al. 2006, 2018) but implicitly not known from Argentina. This species remains without a detailed description of its geographical range. In Colombia for example, it is the most abundant species and is recorded in 23 of the 32 Colombian departments (Sanín 2018). Nevertheless, although Smith et al. (2006) recognized its presence in the neighboring countries, *S. triseriale* had apparently been misidentified as *S. polystichum* (Link) A.R. Sm. because it is the only species of *Serpocaulon* with pinnate laminae listed in Flora of Argentina (Cacharani et al. 2014, 2016, Labiak et al. 2008, Flora de Argentina 2018).

After examining Argentine and Brazilian collections of *Serpocaulon*, we evaluated this possible misidentification and collected data in support that the species recorded in Argentina is not *S. polystichum* but *S. triseriale*. Thus, our aims of our study are to present the new record for Argentina, provide novel micro-characters, and compare it with species that could be confused morphologically with *S. triseriale*, namely *S. attenuatum* (Humb. & Bonpl. ex Willd.) A.R. Sm. (Sanín 2018) known from neighboring Bolivia, and the recently described *S. rex* Schwartsb. & A.R. Sm. (Schwartzburd and Smith 2013) from south-central Brazil.

Methods

Collections of *Serpocaulon* housed at BHCB, COL, CORD, CUVC, FAUC, HNH, HUA, K, LIL, LP, LPB, MCNS, MO, RB, SP, VIC, UPCB, and USM (after Thiers 2018), were examined in full. We focused on the following morphological characters: rhizome scales, laminar dissection, number of pinnae, number of areoles at the middle of the pinna, and number of sori between the costa and the margin. In addition, we carefully studied SEM images of the spores (following Ramírez-Valencia and Sanín 2016), from the type specimen of *S. rex* (P.B. Schwartzburd & L.M. Alves 2596, VIC), and the Argentine collection (*M. Ramos s.n.*, MCNS), which was misidentified as *S. polystichum*.

Results

***Serpocaulon rex* Schwartsb. & A.R. Sm.** J. Bot. Res. Inst. Texas 7 (1): 86–88, fig. 1. 2013.

Type: Brazil, Minas Gerais: Frutal, Reserva Floresta Escola, Floresta Estacional Semi-Decídua, próxima ao Rio Grande, 20°13'58" S, 048°53'03" W, 460 m, 10 August 2012, P.B. Schwartzburd & L.M. Alves 2596 (holotype: SP; isotypes: K, P, UC, VIC!). Figures 1A, B, E, F, I.

New records in Brazil/material examined. Brazil. Goiás: Caldas Novas, at headwaters of the creek, “Rio

Quente”, at the hotel, “Pousada do Rio Quente”, at foot of west side of the Serra de Caldas, 13 km due WSW of city of Caldas Novas, 17°48' S, 048°45' W, 17 December 1974, E.P. Heringer & G. Eiten 14061 (LP). Mato Grosso: 8 km of the Base Camp close to Xavantina–São Felix road, Base Camp at 12°54' S, 051°52' W, 23 April 1968, J.A. Ratter et al. 1020 (K). Mato Grosso do Sul: Aquidauana, Fazenda Feliz entre Terenos e Aquidauana, S.N. Moreira et al. 966 (BHCB); Campo Grande, local Embrapa, 480 m, 20°26'54" S, 054°43'40" W, 19 Dec 2003, V.J. Pott et al. 6534 (BHCB); Sonora, Local CASE (Companhia Agrícola de Sonora), ao longo da descida para foz do Cabecera Alta, 17°37'12.4" S, 054°53'30" W, 17 Aug 2002, V.J. Pott et al. 5669 (BHCB).

Additional examined specimens. Brazil. Minas Gerais: Frutal, Reserva Floresta Escola, Floresta Estacional Semi-Decídua, próxima ao Rio Grande, 20°13'58" S, 048°53'03" W, 460 m, 10 August 2012, P.B. Schwartzburd & L.M. Alves 2596 (VIC); Frutal, Reserva Floresta Escola, Floresta Estacional Semi-Decídua, próxima ao Rio Grande, 20°13'58" S, 048°53'03" W, 460 m, 22 January 2018, D. Sanín & M.O. Duarte 7111 (BHCB). São Paulo: Bauru, Jardim Botânico Municipal de Bauru, lado direito do Córrego Vargem Limpa, 22 December 2005, G.A. Nóbrega & M. Andrade 121 (BHCB); Brotas, viveiro municipal, 470 m, 11 August 1991, A. Salino 1017 (BHCB); Itirapina, mata de brejo junto ao Cerrado da Estrela, 21 July 1991, A. Salino 965 (BHCB); Itirapina, Estação Ecológica de Itirapina, 705 m, 22°10' S, 047°51' W, 12 March 2002, V.A. de Dittrich 1097 (BHCB).

***Serpocaulon triseriale* (Sw.) A.R. Sm.**, Taxon 55(4): 919–930. 2006. *Polypodium triseriale* Sw. J. Bot. (Schrader) 2: 26. 1800 [1801]. *Goniophlebium triseriale* (Sw.) Wherry. Amer. Fern. J. 54(3): 144. 1964.

Type: West Indies, *Anonimo s.n.* (holotype S? following Hensen (1990), isotipo BMj). Figure 1C, D, G, H, J.

New record/material examined. Argentina. Salta. Dpto. La Caldera: camino de cornisa, quebrada húmeda al costado de la RN 9, 1450 m, 24°30'25.9" S, 065°19'26" W, 5 April 2014, M. Ramos s.n. (MCNS).

Additional examined specimens. Bolivia. Beni: Gral. Ballivian, 25 km from Yucumo on Yucumo-Quiquibey road, in the Pilón Lajas, 950 m, 15°17' S, 067°04' W, 16 July 1990, A. Fay & L. Fay 2731 (MO). La Paz: Franz Tamayo, Parque Nacional Madidi, Sector Tanhuara Pata, por el antiguo camino Pelechuco-Apolo, 2259 m, 14°45'17" S, 068°57'24" W, 14 June 2009, A.F. Fuentes & D. Alanes 14192 (MO, LPB).

Brazil. Amazonas: Barcelos, Parque Estadual da Serra do Aracá, Trilha da Cachoeira do Eldorado para o cume, 1000–1150 m, 00°52'29" S, 063°20'27" W, 22 May 2014, P.H. Labiak et al. 5717 (RB, UPCB). Bahia, Nova Viçosa, Fazenda do Janine Caldas, 27 July 1979, E.F. Guimaraes et al. 975 (RB). Goiás: Alto Paraíso de Goiás, Parque Nacional da Chapada dos Veadeiros, entre a guarita de Mutuca e Cruzeiro, 13°58'68" S, 047°30'06" W,

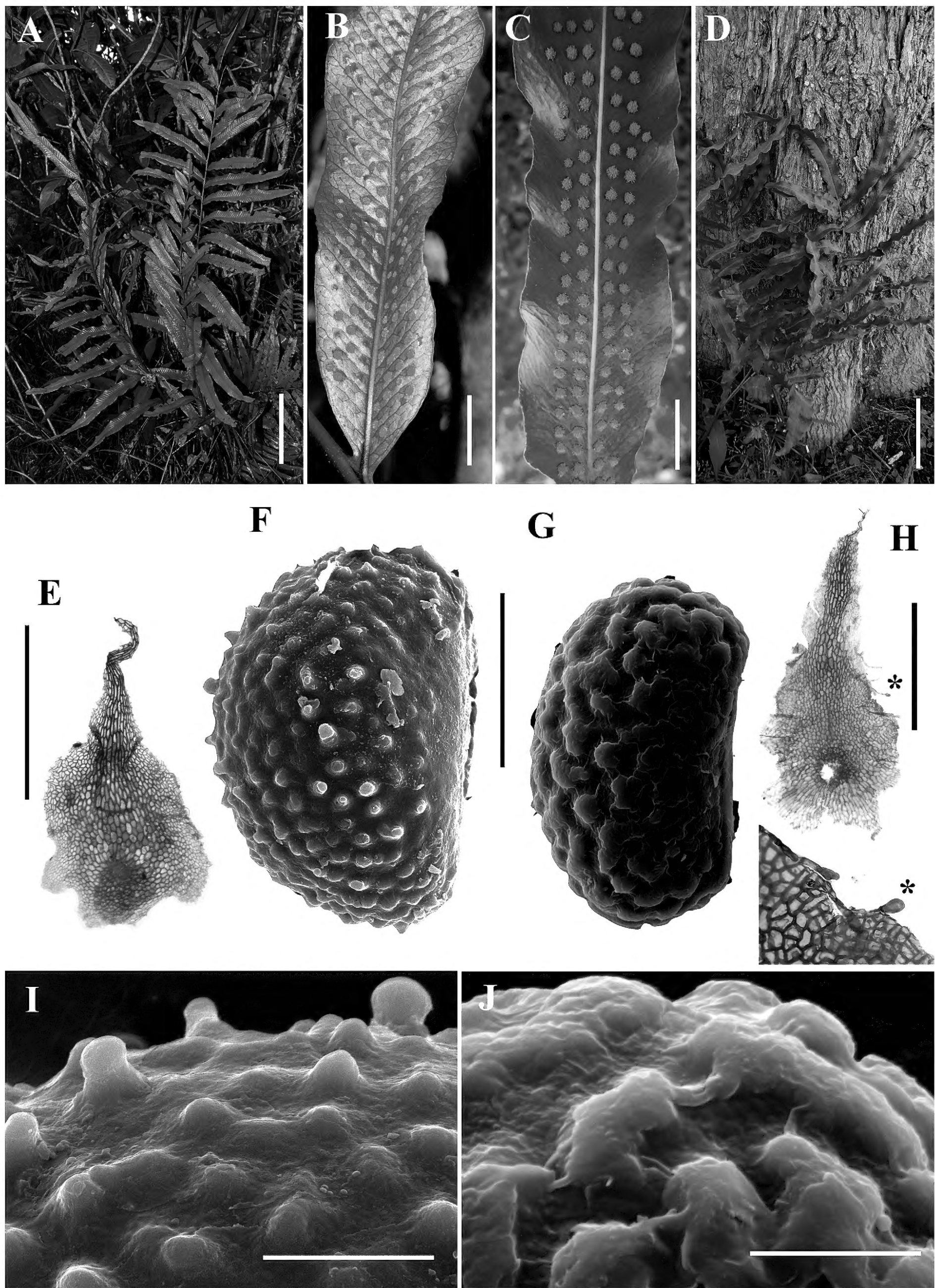


Figure 1. Comparison between *Serpocaulon* species. **A–B, E–F, I.** *Serpocaulon rex*. **A.** Habit, scale bar (10 cm). **B.** Abaxial surface of the pinna, scale bar (1 cm). **C–D, G–H, J.** *Serpocaulon triseriale*. **C.** Abaxial surface of the pinna (scale bar = 1 cm). **D.** Habit (scale bar = 5 cm). **E.** Rhizome scale (scale bar = 3 mm). **F.** Spore (scale bar = 20 µm). **G.** Spore (scale bar = 20 µm). **H.** Rhizome scale (scale bar = 1 mm). **I.** Spore ornamentation detail (scale bar = 5 µm). **J.** Spore ornamentation detail (scale bar = 5 µm). **A–B, E–F, I** from D. Sanín & M.O. Duarte 6087 (BHCB). **C–D, G–H, J** from M. Ramos s.n. (MCNS).

18 April 2009, *G. Martinelli et al.* 16571 (RB). Rio de Janeiro: Cachoeiras de Macacu, Street between Funchal and Guapiaçu, near Regua, 37 m, 22°28' S, 042°45' W, 17 November 2009, *K. Baber & J. Wesenberg* 420 (RB). Minas Gerais: Tabuleiro, Cachoeira de Renato, Poço do Vau, a un lado de la casa de la entrada, 648 m, 19°03'49.61" S, 043°32'13.55" W, 16 February 2018, *D. Sanín & M.O. Duarte* 7116 (BHCB).

Colombia. Antioquia: Cocorná, vereda La Piñuela, carretera a San Francisco, 700 m, 7 June 1991, *D. Giraldo-Cañas* 391 (HUA); Medellín, quebrada El Guamal, entre la vía Las Palmas-av. El Poblado, 1600–1700 m, 18 April 1997, *W.D. Rodríguez-D.* 528 (HUA). Caldas: Chinchiná, vereda La Colina, localidad El alto Español, al borde de la carretera fronteriza entre los municipios de Santa Rosa y Chinchiná, relicto a mano derecha vía Chinchiná, 1728 m, 04°56'34.5" N, 075°41'46" W, 6 March 2006, *D. Sanín* 1892 (FAUC); Manizales-Palestina, empresa Estepan-Colombiana de Químicos, vía Medellín, Tres Puertas, regeneración hacia el margen de la empresa, 1000 m, 3 August 2008, *D. Sanín* 2542 (FAUC). Chocó: San José del Palmar, vereda Damasco, escuela Santa Lucía, 641 m, 21 May 2009, *D. Sanín* 2897 (FAUC). Valle del Cauca: Buenaventura, vista Hermosa-Piangüita, 3 m, 14 July 2010, *D. Sanín* 4207 (CUVC). Vaupés: río Pira Paraná, (tributario del río Apaporis), caño Teemeeña, 6 September 1952, *R.E. Schultes* 17252 (COL); río Kuduyari (tributario del río Vaupés): mediano y bajo cause, 700–800 m, 16 October 1952, *R.E. Schultes* 17904 (COL).

Costa Rica. Heredia: Pto. Viejo, Finca La Selva, 125 m, 18 Jun 1967, *E. de la Sota* 5270 (LP). Guanacaste: 9 km N of Tilarán, 450 m, 25 July 1967, *J.T. Mickel* 2887 (LP).

Ecuador. Imbabura: Along road from Lita to train station, 450–550 m, 5 October 1980, *P.J.M. Maas & L. Cobb* 4729 (HNH).

Mexico. Veracruz: 12 km al E. de Córdoba, cerca de Atoyaquillo, 650 m, 12 December 1964, *Rzedowski* 19080 (LP).

Peru. Junin: Tarma, Huacapistana, entre Tarma y San Ramón, 1800 m, 28 October 1956, *E. Cerrate* 2893 (USM). Loreto: Maynas, Iquitos, carretera Quisto Cocha-Nauta, km 10, 160–170 m, 10 January 1984, *S. McDaniel* 27601 (USM). Pasco: Oxapampa, Dist. Oxapampa, Comunidad Nativa Alto Lagarto-Convento (Reserva Comunal Yanesha), 500 m, 10°08'04" S, 075°22'06" W, 28 February 2014, *R. Rojas & G. Ortiz* 9028 (USM).

Venezuela. Falcón: Sierra San Luis, 2 km E de Cucaide, 1300 m, 14 September 1978, *H.v.d. Werff & R. Wingfield* 3136 (NHN).

Identification. We found that the species of *Serpocaulon* most similar to the single (*M. Ramos* s.n.) Argentine specimen are *S. attenuatum*, *S. rex*, and *S. triseriale* (Table 1). Those 3 species present short-creeping (except in *S. rex*), thick rhizomes (5.7–20 mm) with light brown, patent scales and erect leaves that exhibit a protuberant venation in their pinnae, features that could confound them. A comparison of *S. triseriale* (the putative Argentine pinnate species) with the other 2 species (Table 1) shows that the principal differences are found in the lamina division, with pinnate laminae in *S. rex* and *S. triseriale*, and pinnatifid laminae (with few proximal pinnate pinna and distally pinnatifid) in *S. attenuatum* (Table 1). The Argentine material exhibits a short-creeping rhizome, patent scales, and pinnate laminae. For these key characters, and due to their distribution, we are focusing on comparing *Ramos*'s material, circumscribed as *S. triseriale*, with *S. rex* to discriminate the former as a new record in Argentina.

Serpocaulon triseriale differs from *S. rex* by having short-creeping rhizomes, rhizome scales lanceolate with a long apex, 3–10 × 1–4 mm and marginal projections (vs long-creeping rhizomes with ovate-lanceolate rhizome scales, 5–7 × 2–3 mm and smooth margin), with colored lumen in central cells (vs clear lumen in central cells) (Fig. 1E, H), and pinnae with fewer rows of sori between the costa and the margin (1–4 rows vs 4–6 rows) (Fig. 1B, C, Table 1). The most remarkable difference is in the spores, with *S. triseriale* having flat connected verrucae (Fig. 1G, J), and in a general view, the spores are smaller (57–67.4 × 34–41.6 µm), vs. *S. rex* that shows pronounced not connected verrucae, and larger spores (60–69.3 × 38–45.5 µm) (Fig. 1F, I).

Discussion

The presence of pinnate laminae with proximal pinnae barely adnate and distal pinnae broadly adnate, has been described in the Prodrum of Bolivian Fern Flora (Smith et al. 2018), and the taxonomic revision of *Serpocaulon* of Colombia (Sanín 2018). In the same way, the spores of *S. triseriale* have been widely studied (Murillo and Bless 1978, Hensen 1990, Contreras-Duarte et al. 2006, Coelho and Esteves 2011, Ramírez-Valencia et

Table 1. Comparison between related species of *Serpocaulon*.

Character/species	<i>S. attenuatum</i>	<i>S. rex</i>	<i>S. triseriale</i>
Lamina dissection	Pinnatifid	Pinnate	Pinnate
Rhizome	Short-creeping	Long-creeping	Short- (to rarely long)-creeping
Rhizome scale base shape	Rounded	Auriculate or cordate	Rounded
Number of sori between the costa and the margin	1(–2)	4–6	(1–)2–3(–4)
Verrucae shape	Flat	Prominent	Flat
Verrucae connected	Yes	Not	Yes

al. 2013, Ramírez-Valencia and Sanín 2016), describing that the verrucae ornamentation presents connection between verrucae, and consistent spore size, similar among studied samples. These observations also support our results.

Besides morphological differences between *Serpocaulon attenuatum*, *S. rex* and *S. triseriale*, their distribution is also important to note. Although *S. attenuatum* is said to be widely recorded from Nicaragua to Panama, Venezuela, the Guianas, Colombia to Bolivia, and Brazil (Smith et al. 2006), Smith et al. (2018) suggested a narrow distribution (northern South America from the Guianas to Venezuela and Bolivia). *Serpocaulon triseriale* also presents a wide distribution from Mexico to Paraguay (Smith et al. 2006), but differs with the former by its higher altitudinal range, recorded in Colombia from the sea level to 2500 m (Sanín 2018), in contrast to *S. attenuatum*, which is recorded mainly in lowland areas (Sanín obs. pers.).

The record of *S. triseriale* in Argentina was expected, due to the existence of the corridor represented by the Yungas montane forest. This band of forest occupies the eastern slope of the Andes, between 500 and 3500 m, and goes from Peru to northwestern Argentina (Morrone 2017) and allows for the interconnection of the central and southern Andes (Nores and Cerana 1990).

Serpocaulon rex is endemic to Brazil and has only been recorded in Minas Gerais and São Paulo states, although it might also occur in Mato Grosso do Sul and Goiás (Schwartzburd and Smith 2013). Here, we can confirm that the geographic range of this species does include Mato Grosso do Sul and Goiás.

We also confirm the wide distribution of *S. triseriale* (Smith et al. 2006, 2018, Sanín 2018), and increase its distribution to include Salta province in Argentina, which is the southernmost record of this species. Altogether, our findings support the construction of an accurate biogeographical hypothesis for *Serpocaulon* species, their distributional range, and their conservation.

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